AGRICULTURAL
Research
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CELL RESISTANCE STUDIES

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Health Benefits

Flank attacks by ARS scientists can crumble barriers to improving human health.

Years ago, for example, practically every village had one or two hunchbacks. The drastic reduction of bovine tuberculosis in cattle—and consequently in man—has almost removed this tragic disfigurement from the population of the United States.

At least 80 diseases are transmissible between animals and man. In addition, the principles of disease prevention and other aspects of animal health are similar to those in man. ARS research can thus find many applications in human medicine.

A new oral vaccine against fowl cholera, for example, brings closer to reality an entirely new weapon against dangerous human bacterial diseases like diphtheria. This oral vaccine protects against a type of bacteria and is prepared from killed organisms. Present oral vaccines for man and animals protect only against viruses and require live organisms which may cause accidental infections.

Avian leukosis in poultry (p. 6) is similar to human cancer, although the poultry disease does not infect humans. Knowledge of the virus causing avian leukosis, however, may aid scientists in their search for a virus causing human cancer.

Also aiding cancer research are the ARS botanists conducting a worldwide search for plants that contain cancer-inhibiting substances. Supported by funds from the National Cancer Institute, the search may provide new weapons against cancer and new crops for American agriculture. One substance, extracted from a obscure Chinese tree, looks promising for leukemia control.

And Israeli scientists, working with laboratory animals under a P.L. 480 grant from ARS, found that tranquilizing drugs stimulate a part of the brain called the hypothalamus to increase milk production. An obvious application is increasing production of dairy herds, but in human medicine, this finding may be used to stimulate or stop flow of milk in nursing mothers. The story is on page 11.

Cover photo: Ten-day old chick embryo is removed by geneticist L. B. Crittenden, to prepare a cell culture for virus studies (ST-3614-5). See page 6.

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Orville L. Freeman, Secretary
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Agricultural Research Service

What is PHYTOALEXIN *and how does it work?*

SOYBEAN PLANTS susceptible to phytophthora rot can be protected against this fungus disease by a phytoalexin obtained from resistant plants.

Phytoalexins — "phyto" means plant, "alexin" means warding off compound — are chemical substances produced in plants. The substances, or defense bodies, come into being when two metabolic systems interact—those of a soybean host and a fungus parasite, for example. Phytoalexins were first theorized several years ago by German scientist K. O. Müller.

Finding out what the phytoalexin is and how it works is the goal of plant pathologists D. W. Chamberlain of ARS and J. D. Paxton of the Illinois Agricultural Experiment Station, Urbana.

So far, the scientists have shown that the phytoalexin will protect soybean plants, and that 2 or more compounds are probably involved in the fungitoxic activity. The study of phytoalexins is part of a major research program to learn how plants resist pests; little is known about the biochemical and physiological mechanisms involved.

An understanding of the basic nature of plant resistance should help plant breeders speed the development of pest-resistant crop varieties. Chamberlain's and Paxton's work, for example, may someday lead to a simple chemical test that quickly tells if a soybean breeding line is resistant to phytophthora rot.

The scientists' first experiments showed that inoculating an actively growing soybean plant with a normally non-pathogenic fungus could prevent or reduce infection by a pathogenic fungus.

They used soybean variety Harosoy, which is resistant to the fungus *Phytophthora cactorum* but susceptible to *P. megasperma* var. *sojae*, the fungus that causes phytophthora rot. Plants were inoculated with *P. cactorum*, then with *P. megasperma* in the same wound.

Good protection against *P. megasperma* developed within 24 hours of inoculation with *P. cactorum*. Protection was localized to the wound area, pointing to a phytoalexin as the source of this acquired resistance.

Soybean strain D60–9647 gave similar results. The plants were protected against race 2 of *P. megasperma* by prior inoculation with race 1 of *P. megasperma* to which they are resistant.

Next the scientists demonstrated that phytoalexin could be transferred from its original production site in a resistant plant to a susceptible plant and protect it against infection.

By capillary action, wicks conduct water from beaker through wounds in resistant Harosoy 63 plants nearest beaker; water then picks up phytoalexin and carries it to susceptible Harosoy plants, thus inducing resistance (PN–1636).

In this series of experiments, phytoalexin was produced in Harosoy 63 soybean plants by inoculating them with *P. megasperma*. A wick to transport phytoalexin was threaded through a wound in the hypocotyl of a resistant Harosoy 63 plant and into the hypocotyl of a susceptible Harosoy plant. Inoculum of *P. megasperma* was placed in the wound adjacent to the wick in both plants.

In one test, resistant and susceptible plants were inoculated at the same time; in two other tests, the resistant plant of the pair was inoculated 6 hours before the susceptible one. In all cases enough phytoalexin to protect the susceptible plant against *P. megasperma* was transferred by the string wick. The 6-hour period between inoculation increased protection considerably, however.

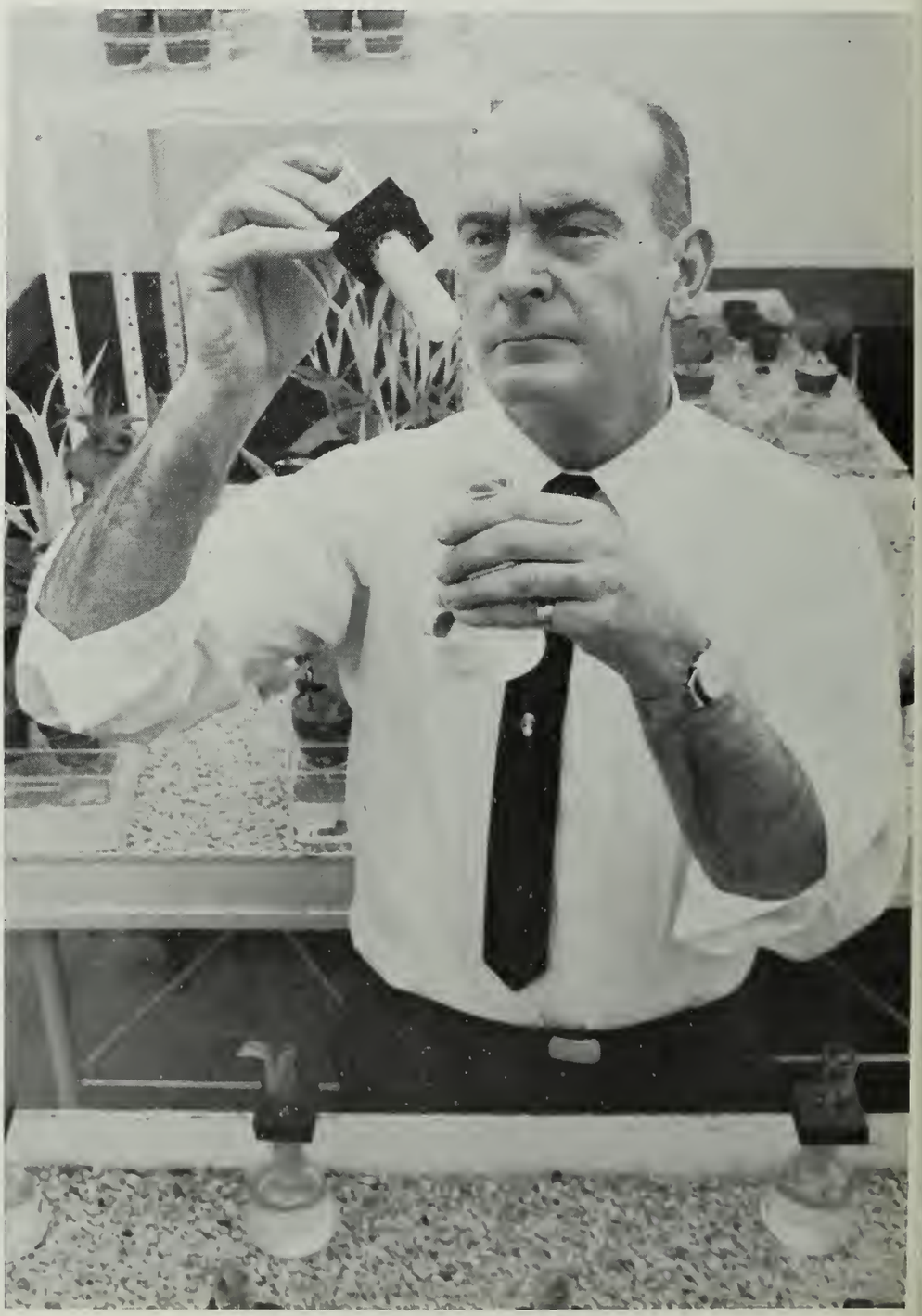
In a second series of experiments, phytoalexin was accumulated in the tips of string wicks for insertion into susceptible plants. The wicks were threaded through Harosoy plants until the wick tips protruded about 1 inch beyond the wound. Plants were inoculated with *P. cactorum* next to the string, and left for 3 days to allow phytoalexin to develop. Uniform portions of the string were then cut off and inserted with *P. megasperma* inoculum into susceptible soybean plants. Again plants were protected against the fungus.

In a third series of experiments, a crude extract was prepared by soaking the string tips in water. This extract was then broken into 10 fractions or parts by chromatography. These were inserted into wounds of susceptible plants to determine which of the fractions contained the phytoalexin.

Two of the 10 fractions gave high levels of protection against the fungus. They represent two or more compounds. These compounds may be phytoalexins, and this possibility is now being explored.■

HERBICIDE EVALUATION

Made easier . . .



A NEW TECHNIQUE INVOLVING a simple apparatus enables scientists to evaluate mere specks of herbicides.

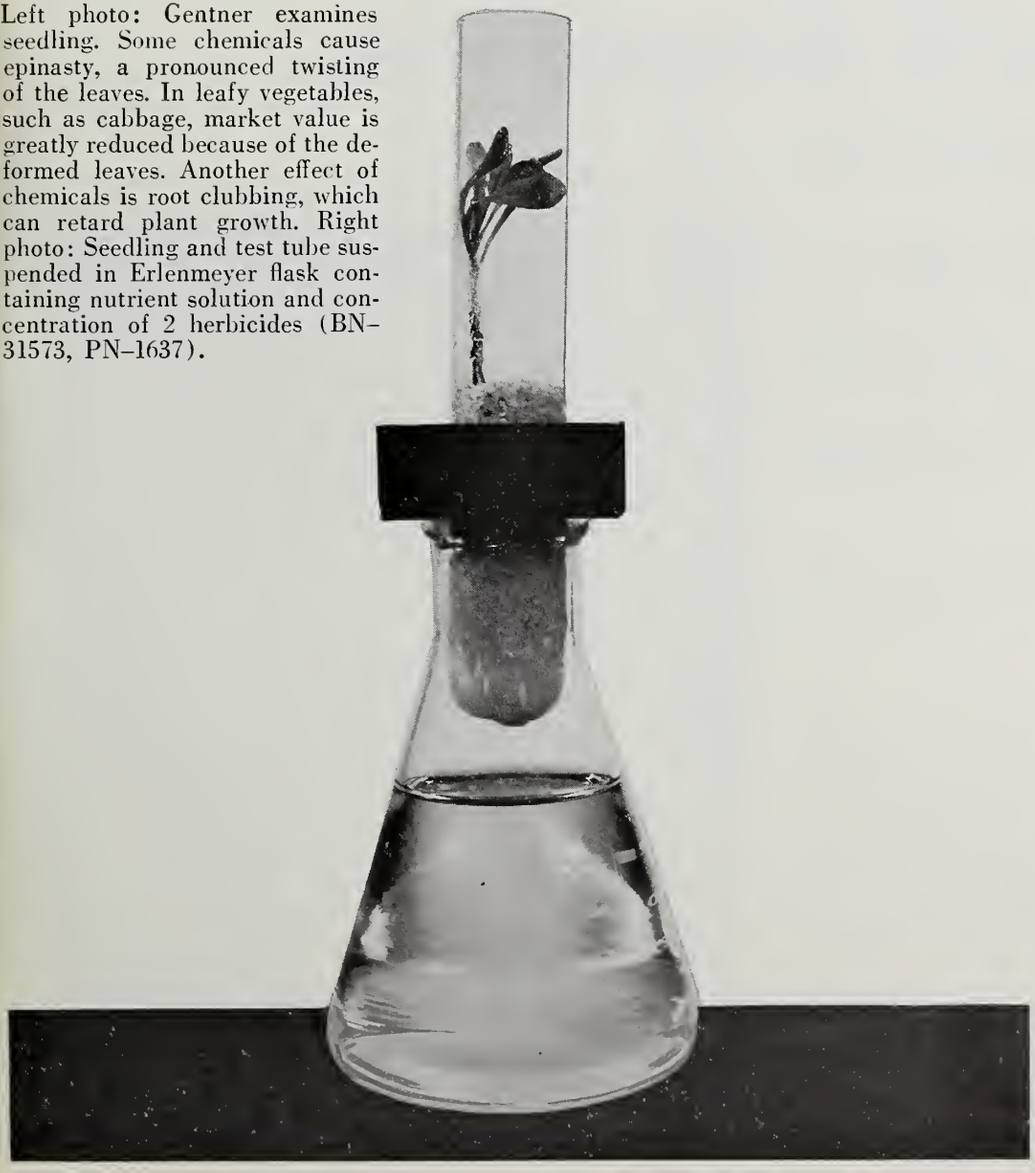
Previously, scientists needed as much as 10 grams to do a similar evaluation. Some experimental herbicide samples are expensive and are often available only in small amounts.

ARS plant physiologist W. A. Gentner developed the technique to help answer a basic question in herbicide selectivity: What is the "pure" effect that the molecular structure of a given herbicide has on plants? To find out, the variables that always develop when herbicides are tested in the field must be eliminated.

With Gentner's device, scientists can also exactly determine a plant's tolerance to a chemical. This knowledge will make possible more precise application of herbicides because the line between a crop plant's tolerance and ill effects from the herbicide will be more sharply drawn.

The apparatus that he built uses simple inexpensive laboratory equipment. First, he took a test tube, drilled a ¼-inch hole in the bottom, put in a little glass wool to serve as a plug, and then filled the test tube to about 1½ inches from the top with quartz sand.

Seed of the plant to be tested was planted in the sand, and the tube was fitted with a rubber collar and suspended in an Erlenmeyer flask containing a nutrient solution and concentration of the herbicide to be evaluated. Once a day the bottom of the tube was dipped into the solution.



Left photo: Gentner examines seedling. Some chemicals cause epinasty, a pronounced twisting of the leaves. In leafy vegetables, such as cabbage, market value is greatly reduced because of the deformed leaves. Another effect of chemicals is root clubbing, which can retard plant growth. Right photo: Seedling and test tube suspended in Erlenmeyer flask containing nutrient solution and concentration of 2 herbicides (BN–31573, PN–1637).

The apparatus is used mainly for testing the effects of herbicides on small-seeded plants such as ryegrass and mustard. For large-seeded plants, like corn or beans, the same principle holds, but the apparatus must be larger; Gentner switches to a common vegetable crisper and a 3-inch flower pot.

In a current experiment, Gentner is measuring the effects of different concentrations of herbicides on 15 plant species.

One of the test plants is the weed matricia, a serious pest of rape which is an important forage crop in Finland. A visiting Finnish scientist is assisting with the experiment, and the data collected may enable him to solve his country's matricia problem.

Gentner points out that while his apparatus gives precise data on the effect that the structure of a herbicide molecule has on the activity of a plant, it is not the whole story of herbicide research and evaluation.

Some herbicides must be tested in the soil because of certain important variable effects. For instance, soil microorganisms convert some herbicide molecules from inactive to active and vice versa.

Also, experiments using the apparatus are conducted either in greenhouses or growth chambers, and since ultraviolet light in natural sunlight breaks down some herbicides, a full evaluation of all herbicides is not possible with the apparatus alone.

Many techniques, including field studies, are necessary to completely evaluate the effects of herbicides.

This work is part of an on-going ARS program of basic research to improve pesticide effectiveness and avoid potential residue hazards. ■

Geneticist Studies

INHERITED RESISTANCE

CHICKENS GENETICALLY resistant to lymphoid leukosis gain this protection because the walls of their body cells resist penetration by the causal virus.

Recent studies by ARS geneticist L. B. Crittenden on the mechanism of cell resistance add to his earlier finding that variation in just one unit of inheritance, or gene location, determines whether a chicken is genetically resistant to a specific lymphoid leukosis virus strain (AGR. RES., March 1966, p. 4). Details about inherited leukosis resistance provide useful clues for poultry breeding work. This poultry research may also advance studies on cancer genetics in mice and possibly in humans.

A cell can counteract virus reproduction with one of three properties:

- It may fail to furnish certain molecules that a virus needs to get a foothold on the cell wall. This is why chickens can fend off polio virus.
- The cell wall may resist penetration by the adhering virus—a mechanism by which rabbits resist echo virus, an instigator of human colds.
- A cell may prevent a virus that penetrated the wall from using the cell's reproductive machinery, as happens to adeno virus invading resistant African green monkey cells.

In his latest research, Crittenden eliminated the anti-attachment mechanism as being involved in resisting lymphoid leukosis virus. He grew chicken cell cultures in plastic dishes and covered them with a suspension of viruses. The viruses dropped out of suspension as quickly in dishes containing resistant chicken cells as they did in those containing susceptible cells. This indicated that both cell types provided footholds.

Crittenden then studied the two remaining possibilities by mixing susceptible and resistant cells in the same culture dish. He hoped to overwhelm resistant cells with masses of virus on all sides, possibly aided by transfer of viral or cellular genetic matter from susceptible to resistant cells through cell fusion.

If the virus grew inside new genetically resistant cells, Crittenden would have helped virus penetrate normally resistant cell walls. He made sure that all new tissue growth would be from resistant cells by exposing infected, susceptible cells to irradiation before adding them to the cultural mixture. This stopped susceptible cells from multiplying without interfering with the rapidly growing population of virus inside them.

Within 30 days, Crittenden found virus in new tissue growth. Microscopic identification verified that this new growth was from genetically resistant cells. Resistant cells had been taken from male chick embryos, the susceptible cells from female embryos. The cells could be readily differentiated since females have one less chromosome in the cell nucleus.

Viruses appeared to reproduce in infected cells as usual, pointing to the cell wall as the apparent barrier of resistant cells. Future research will try to establish what property of cell walls gives them the power to exclude attacking virus under normal circumstances. ■

Crittenden places embryo on a stirring table to disperse the cells for the culture. White bar contains magnet, which turns with a magnetized disc inside table, eliminating need for inserting spatula into sterile mixture (ST–3614–14).

P. A. Sarvella (left) holds the hybrid chicken-pheasant produced by crossing the Dark Cornish rooster, held by M. C. Gehman (center), and the Ringneck pheasant hen, held by J. V. Motta (right) (ST–3280–2).

Rare Avian Crosses Aid Genetic Studies

OUR KNOWLEDGE of the genetics of evolution is being advanced by producing live offspring from rare crosses between species of pheasants and between chickens and pheasants.

In recent ARS research, crosses were made between the Reeves pheasant male and the Ringneck pheasant female, and between the Dark Cornish rooster and the Ringneck pheasant hen.

Geneticist P. A. Sarvella at Beltsville, Md., made the crosses to determine evolutionary relationships between these avian species, and to see how genes might be transferred from one species to another. The hybrids, hatched last summer, are a follow-up to the previous study of crossbred Dark Cornish-Japanese quail made by Sarvella (AGR. RES., Mar. 1967, p. 3).

The gametes, or germ cells, of the male hybrids will be examined to see how the chromosomes are paired. If, for example, all the chromosomes are paired, the two parent birds are closely related. This type of information gives Sarvella an idea of their evolutionary pattern.

The Reeves and Ringneck pheasants do not normally interbreed. They are not only members of different species, but also of different genera, or groups of species. The Reeves species belongs to the genus *Syrmaticus*, and the Ringneck belongs to the genus *Phasianus*.

Some Reeves-Ringneck hybrids were weak and had to be aided in hatching. They are believed to be fertile.

The Reeves-Ringneck crosses have characteristics of both of their parents. The male hybrids have the white head, black mask, and some gold wing feathers like the Reeves, the iridescent purple breast like the Ringneck, and an intermediate tail length.

The cross between the Dark Cornish rooster and the Ringneck pheasant hen was more unusual because these birds are even more distantly related than the Reeves and the Ringneck.

The sexes of the hybrid chicken-pheasants are not yet known, but will be ascertained after cytological samples are taken. Sarvella believes these crosses are sterile, and she may inject them with hormones to increase their chances of fertility.

The chicken-pheasants do not have the appearance of either parent. Some of the hybrids are small and others are large. Some have only black feathers like their Dark Cornish father, but others have an intermingling of brown feathers like their mother. Black legs appeared in some of the hybrids, although neither parent has this characteristic.

This spring Sarvella plans further studies with the pheasant hybrids. She will breed males and females in the group to each other as well as to purebred Reeves and Ringneck pheasants. From backcrossing, she will attempt to learn which genes are dominant and if it is possible to transfer genes from one species to another. ■

TECHNIQUE CUTS
. . . of Tracing Pesticides

An ARS scientist has developed a technique to cut the time and expense of tracing the movement of pesticides through soil.

ARS has a major program to learn how every pesticide acts in the soil. The overall goal is to improve pesticide safety and effectiveness.

Crop scientist C. S. Helling's new low-cost, time-saving tracing technique developed at Beltsville, Md., can trace the movement of as many as 30 compounds per day. Previous methods required weeks or months.

Furthermore, the new technique yields kinds of data that cannot be obtained at all with the old methods.

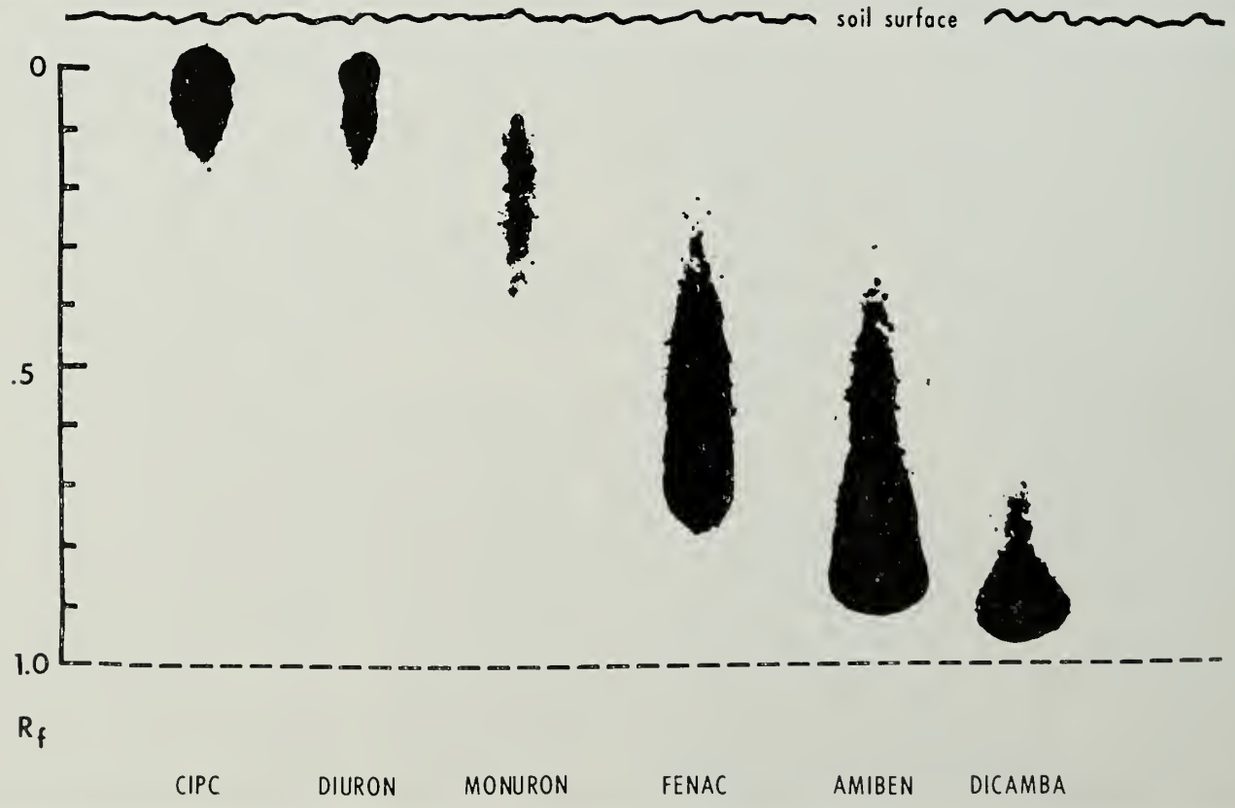
Helling tags the pesticide compound with a radioactive isotope such as carbon 14, so he can get an actual image on X-ray film of its movement. The X-ray image tells such things as whether the pesticide moves in a compact band or spreads out, and whether it interacts with, or simply moves through the soil.

Only a small amount of soil is used. This could be important in working with a soil hard to obtain. The technique works with any soil, from sand to clay.

Helling selects soil and sieves it, but does not otherwise alter it. Next, he mixes water into the soil, prepares a slurry, puts the slurry into an applicator, and spreads a uniformly thin layer over a glass plate.

He places small drops of tagged pesticides on the soil layer at the bottom of the plate, then places the plate in a closed container with the bottom of the plate resting in water.

Water moves by capillary action through the thin layer of soil just as it does in the field. After the water has moved through the soil, Helling removes the plate from the closed container and places a sheet of X-ray film over it. X-ray film is sensitive to radioactivity, and, after 2 or 3 days—depending on how "hot" the radioactive



TIME AND EXPENSE in Soil

isotope is—an image on the film shows exactly how the pesticide moved in soil.

A major advantage is that more than one pesticide can be traced at the same time on the same plate. Helling has traced up to seven pesticides simultaneously on one plate.

The only things that are used up are a little radioactivity labeled pesticide and the X-ray film. Much of the equipment could be improvised, including the applicator. Helling says that simple window panes could serve as glass plates, and an empty pickle jar could easily be used as the closed container.■

Far left: Autoradiogram showing downward movement of 6 pesticides in soil. CIPC is less mobile, while dicamba is most easily leached. The R_f scale shows movement relative to the water front indicated by broken line (PN–1638). Left: Helling applies thin layer of soil to glass plates with an applicator (PN–1639). Above: Soil covered plate rests in water in a closed container. Water moves upward through the soil by capillary action, carrying radioactive pesticide with it (PN–1640).

For Distinguished and Superior Service

For their outstanding achievements, 9 individuals and four groups of ARS employees recently received Distinguished and Superior Service Awards.

Secretary of Agriculture Orville L. Freeman presented the awards at USDA's 22d annual awards ceremony held May 14 at Washington, D.C.

Wilson A. Reeves
Chief, Cotton Finishes Laboratory, ARS (PN–1641).

For Distinguished Service

Wilson A. Reeves, *Southern Utilization*, for development of the theory and practice of improving the properties of cotton textiles by chemical modification and additive finishing.

For Superior Service

Gordon Alderton, *Western Utilization*, for the discovery that bacterial spores have ion-exchange properties which correlate with their resistance to destruction by heat and for devising an improved process for sterilizing canned foods based on this finding.

Myron K. Brakke, *Crops*, for solving problems of plant virus occurrence, identification, and transmission in cereal crops and developing and using improved chemical, physical, and biological methods for virus characterization.

Royden O. Butterfield, *Northern Utilization*, for pioneering achievements in the interdisciplinary research area of simulating chemical and physical processes on analog and digital computers.

William C. Cooper, *Crops*, for outstanding contributions to the field of citrus culture as related to growth-regulating hormones, salt tolerance, cold hardiness, and fruit abscission.

Allen G. Pittman, *Western Utilization*, for inventing economical oil-and-water-resistant finishes for wool and other textiles through the synthesis of new types of fluoropolymers and study of their surface properties.

Carroll N. Smith, *Entomology*, for advancing research in medical entomology of outstanding value to military and civilian health agencies throughout the world.

Tien Chioh Tso, *Crops*, for incisive research and forceful leadership in tobacco studies to identify and reduce or remove health hazardous materials.

Adelaide W. Wells, *Crops*, for outstanding contributions in developing procedures, methods, and practices tailored to the expanding budget and financial management needs of her Division's scientific programs.

Biopolymer Research Team, *Northern Utilization*, for outstanding creativity and highly significant research resulting in the discovery, development, industrial acceptance, and commercialization of a new gum of cereal grain origin.

Snake River Conservation Research Center, *Soil and Water*, for superior organization and development of a vigorous, well-rounded research program geared to the vital needs of the Snake River Plains.

Soil Resistant and Soil Release Research Group, *Southern Utilization*, for the development of a soil release finish for durable press and wash-wear cottons based on carboxymethylcellulose.

Sugarbeet Investigations, *Crops*, for development of basic parental lines and hybrids of monogerm sugarbeet that eliminates the need for hand thinning and permits complete mechanization of production.■

P.L. 480
RESEARCH

israeli studies...

MAY LEAD TO INCREASED MILK PRODUCTION

TRANQUILIZING DRUGS THAT stimulate a part of the brain called the hypothalamus can increase milk production in laboratory animals, Israeli scientists report.

Increasing production in dairy herds is one of several possible practical applications of findings in this research. Other possibilities include increasing milk flow in animals nursing their young, and using hypothalamus-inhibiting drugs when it is desirable to stop milk production.

There may also be application in human medicine, for stimulating or stopping flow of milk in nursing mothers.

The research is being conducted at Hebrew University, Jerusalem, under a P. L. 480 grant supervised by ARS. F. G. Sulman is principal investigator.

The main ARS objective in awarding the grant was to clarify the complicated mechanism of lactation. Biochemist Joel Bitman is ARS sponsoring scientist.

Lactation requires the action of many hormones in the process of synthesizing casein, butterfat lactose, calcium, and other components of milk. The Israeli scientists say this interplay of hormones needs the regulating action of the hypothalamus, which assumes the function of the "conductor" to an orchestra.

The hormones involved, and how they interact, vary from species to species. There are still many unknowns in the process.

Rats and rabbits were used in most of the Israeli experiments. The research could lead to application in other mammals, however, because it clarifies the basic role of the hypothalamus. It "conducts the orchestra," regardless of the species.

Israeli scientists identified two hypothalamic centers—the posterior center and the anterior center. Sulman says that in rats and rabbits secretions from these centers control release of the hormone prolactin, which is secreted by the pituitary gland. Prolactin, in turn, activates many other hormones.

Sulman says the posterior center of the hypothalamus produces a prolactin inhibiting factor (PIF), which is active when an animal is not nursing. The anterior center produces a prolactin releasing factor (PRF), which is active when the animal is nursing.

By giving injections that depressed PIF secretion and encouraged PRF secretion, the investigators increased milk production in nursing rats and rabbits.

Some drugs converted non-developed mammary glands of virgin female rats into well-developed glands containing milk.

In 5 years of study, the Israeli scientists tested more than 160 compounds, more than half of them phenothiazine derivatives. Some phenothiazines are active tranquilizers.

The investigators took a major step when they found that by changing the molecular structure of some phenothiazines, they could avoid the undesirable tranquilizing action and still induce mammary development and increase milk production through hypothalamic stimulation. The most promising of these substances have been patented by USDA.

Because these substances do not cause undesirable depressing side effects, they may have value in human medicine research.

Bitman says that in view of the excellent progress made in this project, ARS recently renewed the grant. ■

Dairy research assistant C. E. Swartz, Jr., adds a 28-percent crude protein grain mix to corn silage after taking it from the silo. About 80 percent of this time is saved by putting grain with chopped corn before filling the silo (PN–1642).

Grain and Silage Can Be Stored Together

FARMERS CAN USE silage unloaders to automate grain feeding by adding grain to chopped corn as it is put into the silo.

At present, farmers mechanize grain feeding by channeling grain into the flow of silage as it is unloaded. This requires separate storage and unloading facilities for the two feeds (AGR. RES., Sept. 1967, p. 10).

ARS dairy nutritionist J. C. Derbyshire found in a 3-month trial that the two feeds can be stored and unloaded together without reducing the feeding value of the total ration. This method also brings considerable savings in labor or machinery.

Researchers prepared a complete feed of a 28-percent crude protein grain mix and good-quality corn silage in two ways. In one silo, 150 pounds of grain was added to every 1,000 pounds of chopped corn as it came from the field. In another silo, the chopped corn was stored alone; the required grain was added when the silage was fed—more than 3 months later.

It required about 1¼ extra hours of filling time to add grain to silage when the two feeds were stored together. This compares with 6 hours of extra work to add grain to silage at feeding time.

The silos were filled from a conventional self-unloading wagon, and grain was spread on top of the load when grain and forage were stored together. The beating action of unloading thoroughly mixed the two feeds, and they remained well mixed during unloading.

Although the cows received no additional grain, they maintained their usual daily average of 44 pounds of milk with a 4 percent butterfat content. Feed consumption was equal, regardless of when the complete ration was mixed. The average weight of cows increased on the complete feed as the 3-month trial continued—further proof that both diets were more than adequate for milk production.

Derbyshire recommends mixing grain and silage before storage. His present data involved corn silage only, but he expects that mixing before storage should also work with grass silage. This will be checked with the 1968 grass-silage crop at Beltsville, Md., where the trial with the corn silage took place.

Three points are vital in storing a complete feed:

- Slightly less silage can be stored if grain takes up some of the silo space.
- Care in making silage is doubly important, because silage losses will also result in grain losses. Derbyshire, however, recovered 97 percent of the dry matter stored, with only 1 percent spoilage, using a conventional concrete silo, sealed after filling.
- Sharp computation is needed to determine the amount of grain supplement to be fed. An overestimate would be costly because there's no way to correct it later.■

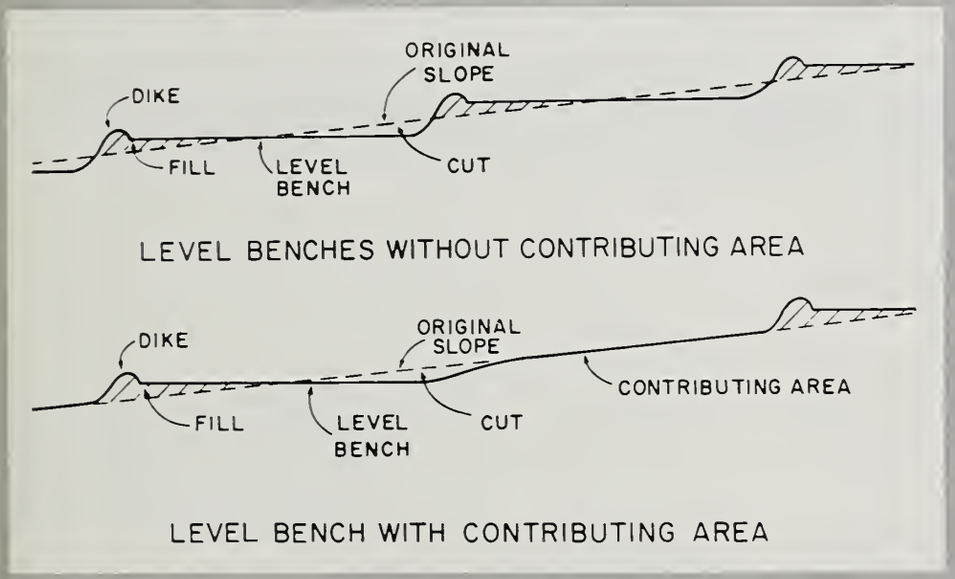
. . . Twice as much Forage with Level Bench Systems

LEVEL BENCH SYSTEMS have doubled the yields of alfalfa and bromegrass grown on slopes, almost assuring them a definite place in Northern Great Plains agriculture and in the hearts of livestock producers.

Level benches, first introduced in the United States for study in 1955 by ARS after centuries of use in other countries, are similar to conventional terraces but are level in all directions.

Diked in front and at the outer edges, they have a greater water storage capacity than conventional terraces and aid in curbing soil erosion. Generally, the steeper the slope the narrower the benches. Wide benches on steep slopes result in severe soil cutting and reduced yields.

A study being made by ARS soil scientists H. J. Haas and W. O. Willis near Mandan, N.D., shows that twice the forage can be produced by the method.



Above: Diagrammatic profile of two level-bench systems with and without contributing areas (PN–1643). Below: Level-benches hold snowmelt water until the soil thaws and allows the water to enter. Runoff and erosion are eliminated. The tubes on the benches are for measuring soil water with a radioactive probe (PN–1644).

Benches used during the study ranged from 30 to 70 feet wide on slopes of 1 to 9 percent, some with contributing areas and some without. Contributing areas are parts of the slope above the benches left to aid drainage into the benched areas. Greatest total forage yield can be expected from fields with level benches only, rather than from fields with contributing areas.

Average alfalfa yields (1963–66) on nonbenched slopes was 1,910 pounds per acre. Bromegrass averaged 900 pounds per acre during the same period.

On level benches during that time, alfalfa averaged 3,700 pounds while bromegrass averaged 1,650.

With the use of fertilizer, alfalfa averaged 3,890 while bromegrass went to 3,140 pounds per acre—almost four times that on nonbenched slopes.

Since the systems are essentially permanent, construction costs can be pro-rated over a number of years. Costs vary according to soil types and geographic locations. In the Mandan area costs ran about $90 to $100 per bench acre for 50-feet-wide benches on a 2 to 6 percent slope.

Narrower benches of 12 feet will cost considerably less, can be constructed easily with a road grader, and may also collect more snow than wider ones.

Further study in the Mandan area will determine maintenance requirements of benches or dikes grazed by cattle.

Research on the level bench system is also being conducted at other Great Plains locations. In general, level benches increase crop yields. However, in the southern plains summer rainstorms contribute most of the water, while in the northern plains the water is derived primarily from trapped snowmelt.■

SANDBINDING GRASSES . . . now economically feasible

IT'S NO LONGER TRUE that making sand dunes "stay put" in the Texas and Oklahoma Panhandles and southwestern Kansas is not economically sound.

An ARS study shows that grasses can be established and kept on these dunes at justifiable cost if a few cultural requirements are met:

- Keep livestock off until a grass cover is established.
- In the spring of the first year, broadcast a complete fertilizer, at the rate of 300 pounds per acre, on the windward side of the area to be revegetated. This will give grass a foothold, from which it can spread across the dune. Every spring, apply nitrogen fertilizer to the advancing edge of the grass—fertilize the area covered by the previous year's advance.
- If it's considered desirable to seed bare areas rather than wait for the existing vegetation to spread, plant grass seed and mulch. Spread 2½ tons of hay per acre for mulch and anchor the mulch with a tillage implement such as a disc packer.
- Carefully manage grazing after grass is established. Don't overgraze.

Observing these steps, the researchers obtained satisfactory stands of sandbinding grasses. Grasses native to the area performed much better than introduced grasses. Major native grasses are giant sandreed (*Calamovilfa gigantea*), sand bluestem (*Andropogon halii*), blowout grass (*Redfieldia flexuosa*), and giant dropseed (*Sporobolus giganteus*).

The study was conducted by soil scientist H. V. Eck, agricultural engineers R. F. Dudley and C. W. Gantt, Jr., and technician R. H. Ford. Site of the study, which spanned 5 years, was a dune area in the Oklahoma Panhandle 30 miles south of Liberal, Kans., and 20 miles north of Perryton, Tex. The Texas Agricultural Experiment Station cooperated in the work.■

River flow NOT affected by CONSERVATION practices

MASSIVE ADOPTION of conservation measures to control flooding and erosion in an Oklahoma river basin has not affected water supplies available down stream for urban, irrigation, and recreation needs.

Research by ARS hydraulic engineer M. A. Hartman indicates that conservation installations of the past 20 years have not modified the average flow of the Washita River. Runoff recorded at Durwood, Okla., varies seasonally, but long-time trends have held steady for 37 years.

The Washita is 1 of 11 rivers for which Congress authorized a basin-wide conservation effort in 1947. Since then, three major dams and 800 flood-prevention structures have been built. And 70 percent of needed conservation practices have been established on cultivated land and pastures.

Hartman's conclusions are based on detailed field observations and computer analysis of data collected by the U.S. Geological Survey. He also found:

- Major floods—with peak flows of 100,000 cubic feet per second—can now be expected no oftener than once in a century. Prior to establishment of conservation measures, floods of such magnitude occurred about every 20 years on the Washita. And flood frequency studies indicate that large floods still recur at 20-year intervals on the nearby Kiamichi River, where few conservation practices have been applied.
- Fluctuations in rate of streamflow have been reduced on the Washita. A comparison of number of days with three flow rates shows a 20-percent decrease in high flows, a 50-percent increase in intermediate flows, and a 30-percent decrease in low flows. And the duration of low flow probably would have declined more if withdrawals from the river for industrial and irrigation use had not risen in the past two decades.
- Annual runoff at Durwood has varied from one-half to 3 million acre-feet since 1928, with cycles of low and high runoff alternating every 7 to 10 years. This variation, partly in response to climate, has not been affected by changes in land use and installation of flood-control structures.

Hartman points out that both volume and rate of streamflow have been modified locally within the upper Washita basin. For example, floodwaters that would have been absorbed in the floodplain are now temporarily held in reservoirs with a combined storage capacity of 364,000 acre-feet. But such upstream changes in location of stored water have not affected the downstream flow of the river.

The research, in cooperation with the Oklahoma State University and the University of Oklahoma Research Institute, was conducted at the Southern Great Plains Watershed Research Center, Chickasha.■

AGRISEARCH NOTES

Beef-Dairy Crossbreeds

Calves born to Brown Swiss dams bred to bulls of beef breeds weighed more and made higher daily gains than other crosses or straightbreds in a recent ARS study.

Brown Swiss dairy cows were bred to Hereford, Angus, and Charolais beef bulls. Matings also were made between bulls and cows of these three breeds to compare all possible straightbred and crossbred combinations with the beef-dairy crosses.

Data were collected over a 4-year period at the U.S. Range Livestock Experiment Station in Miles City, Mont., by ARS cattle researchers O. F. Pahnish and J. J. Urick, ARS statistician B. W. Knapp, and J. S. Brinks, now

of the Colorado Agricultural Experiment Station, Fort Collins.

On the average, crossbred steers from Brown Swiss mothers outweighed steers from beef mothers by 12 pounds at birth, even though both groups of steers were sired by the same bulls. Crossbreds with Brown Swiss mothers gained 0.3 pound more per day before weaning and weighed 74 pounds more than the beef breeds when both were weaned.

The researchers say the heavy birth weights of calves born to Brown Swiss mothers can be associated with the relatively large frame of that breed. The high level of milk produced by the Brown Swiss dam appears to have contributed to the fast preweaning gains of their crossbred calves.

Sodium Chlorite Treatment

Chemical treatment with sodium chlorite dramatically raises the digestibility of poor-quality roughage, such as wheat straw or peanut hulls.

ARS animal nutritionist H. K. Goering says that such products are poorly digestible in their natural state because a single substance, lignin, ties together the molecules of fibers in cell walls, making them resistant to digestion by ruminants.

Within 30 days after adding 3 pounds of chemical to 100 pounds of straw in a silo, wheat straw digestibility went from 53 to 93 percent, and peanut hull digestibility from 17 to 91 percent. A wide range of other forages was tested, with similar improvement in digestibility. These were preliminary studies.

The research at Beltsville, Md., now centers on overcoming such drawbacks as high cost and the considerable heat, toxic gases, and table salt produced in the treatment.

The heat and gas pose a fire hazard without proper ventilation, and the gas is noxious to man and animals. Table salt lowers the amount of feed consumed, so that treated feed could not satisfy more than half the normal daily feed needs of sheep. A new compound may, hopefully, be developed that does not have these disadvantages, Goering says.

Unisexual Insect Strain

A recently discovered strain of the salt-marsh caterpillar produces only female offspring. In this unusual strain, developing male embryos are killed by a lethal substance in the cytoplasm (cell fluids).

Entomologist N. W. Earle of the ARS Cotton Insects Research Laboratory in Baton Rouge, La., and J. MacFarlane, a graduate assistant at Louisiana State University, discovered this unisexual strain while they were studying the sex attractant in the salt-marsh caterpillar.

Although the unisexual strain is a scientific curiosity with little practical value at this stage of research, it will be used in future genetic studies.

Earle and MacFarlane have maintained the unisexual strain for seven generations. The salt-marsh caterpillar is a pest of cotton and other crops in Arizona.

The researchers have found that the unisexual trait can be passed to normal strains by injecting female pupae (cocoons) with blood from pupae of the unisexual strain. The mature injected females produced only female offspring when mated.

Their offspring produced progeny of both sexes, however, indicating that the unisexual condition did not become permanent.

Theoretically, if this strain did become abundant, a shortage of males and a decrease in matings would bring a decline of this pest in future generations.

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Citrus Tablets

Oranges and grapefruit may one day be served in tablet form according to ARS scientists who have made the tablets in research conducted to develop new uses for citrus.

The tablets—eight equal one orange or about half a grapefruit—are light in weight, pleasant tasting, and inexpensive. They are made from orange or grapefruit crystals, two recent ARS developments.

The tablets, or discs, were developed at the ARS Fruit and Vegetable Laboratory at Winter Haven, Fla., by chemists R. E. Berry and C. J. Wagner, Jr., during efforts to improve the solubility of the citrus crystals. The crystals are made by drying concentrated citrus juices. As the crystals come from the dryer, they are light and fluffy and tend to float on the water instead of sinking quickly and dissolving.

To obtain particles with better solubility, the scientists developed a method of pressing the powder between steel rolls to form a sheet, then grinding the sheets. During these studies powder was also compressed into discs, which the chemists noticed can be eaten like candy fruit drops. Children seem to like them especially.

The discs—about the size of a 25 cent coin—could result in new outlets for both grapefruit and oranges as nutritious confections for everyday use or even as a lightweight, compact means of supplying nutrients in citrus fruits to campers, servicemen in the field, or astronauts in the Nation's space program.

ARS Helps USAF

When the U.S. Air Force discovered that black carpet beetles and furniture carpet beetles had invaded its warehouses, it looked to ARS for help.

The material USAF uses to cushion and protect delicate instruments and electronic equipment during storage, handling, and shipping is largely composed of animal hair, a favorite in the diets of both species of carpet beetles.

Infestation was widespread and damage so extensive that numerous crates had to be opened, inspected, and repacked with new cushioning. Often, equipment had to be returned to shops or factories for recalibration.

A DDT-lindane space treatment, previously developed in the ARS Stored-Product Insects Laboratory at Savannah, Ga., for use in nonsubsistence warehouses, was started immediately. This controlled insects in the warehouses, but didn't affect beetles infesting the packing material inside the crates. Fumigation of the crates was ruled out as being too costly, because it would interfere with normal activities, and because of the possible harmful effects of the fumigant on the equipment.

In view of this, researchers at the Savannah laboratory concentrated on developing a preventative measure—a means of "beetle-proofing" cushioning material during manufacture or before it would be used for packing. They first applied DDT directly to the animal hair, but found that the insecticide interfered with the manufacturing process. In addition, the manufacturing process rendered the DDT ineffective.

They successfully devised a method of spraying a water-emulsifiable concentrate of DDT on the finished product. The residue effectively controlled insects without harmful effects to the cushioning material.

Laboratory researchers also designed a sprayer for use at Air Force bases having inventories of untreated cushioning.

The ARS research has virtually eliminated the need for periodical opening, inspecting, and repacking of containers.

Solving USAF's problem took ARS less than six months and cost only $2,200, compared to an estimated $300,000 initial savings.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

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